ELSEVIER

Nuclear Instruments and Methods in Physics Research B 123 (1997) 47–50

NIM B
Beam Interactions with Materials & Atoms

VERA: A new AMS facility in Vienna

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Abstract

The basic features of VERA, a new AMS facility based on a 3-MV Pelletron tandem accelerator installed at the University of Vienna, are presented.

1. Introduction

VERA is an acronym for Vienna Environmental Research Accelerator, a new dedicated center for accelerator mass spectrometry at the University of Vienna. It is based on an AMS system with a 3-MV Pelletron tandem accelerator (Model 9SDH-2), built by National Electrostatics Corporation in Wisconsin, USA. In 1993, the Austrian Federal Ministry of Science and Research (responsible for all universities in the country) decided to finance this new facility. An important factor for this decision was the evaluation of all physics institutes in Austria by an international committee in the early nineties, which recommended a dedicated AMS facility as an appropriate investment into the future of science and research in the country. As a result, VERA was ordered in 1994, and was delivered to Vienna in the fall of 1995. After installation, which lasted about two months, VERA went into test operation. It is envisioned that by the end of 1996 it will become available as a full AMS research facility at both national and international level.

An important design feature of VERA is the capability of accelerating and transporting ions up to the heaviest elements, which allows one to perform (in principle) AMS experiments with any radionuclide or stable nuclide of the entire nuclear chart. The name of the facility indicates its primary mission, i.e. the tracing of long-lived natural and artificial radionuclides in the seven domains which make up our environment at large: atmosphere, biosphere, hydrosphere, cryosphere, lithosphere, cosmosphere, and technosphere. There are numerous examples that AMS is well-suited to perform measurements in these domains (see Ref. [1] for a comprehensive list). The present paper gives a brief overall description of VERA with emphasis on the general layout and the scientific goals. In a separate paper [2], the first performance characteristics of VERA are presented.

2. The VERA laboratory

VERA is located near the center of the city of Vienna close to the Physics Department of the University of Vienna. It is housed in the so-called "Kavalierstrakt" at Währingerstrasse 17, A-1090 Vienna, which is a small two-storied palace from the last century under landmark protection. The interior of this building was completely reconstructed to generate a modern laboratory for AMS. At the same time, efforts were made to preserve as much as possible the original features of the building. Fig. 1 shows the floorplan of the building. The total floor space available (~ 600 m^2) was divided into four areas of roughly equal proportions: accelerator, mechanics and electronics shops, sample preparation, and offices including a seminar room. Particular emphasis was placed on providing ample space for sample preparation. The S-shaped accelerator room was formed by removing the walls between three adjacent rooms. The AMS system was fit into the available space in a way which allows future extension beyond the current setup. For this reason, we chose a straight beam line after the analyzing magnet, with a Wien Filter as the background clean-up device rather than the more common electrostatic analyzer. A switching magnet between the analyzing magnet and the Wien Filter will allow a future extension at a 20° deflection for a more elaborate analysis system for heavy radionuclides.

For the installation of the accelerator tank, the relatively small entrance door to the accelerator room (near the control console) had to be temporarily widened. Maintenance of the accelerator structure can be conveniently performed by rotating the tank clockwise around a pivot

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PII S0168-583X(96)00782-3

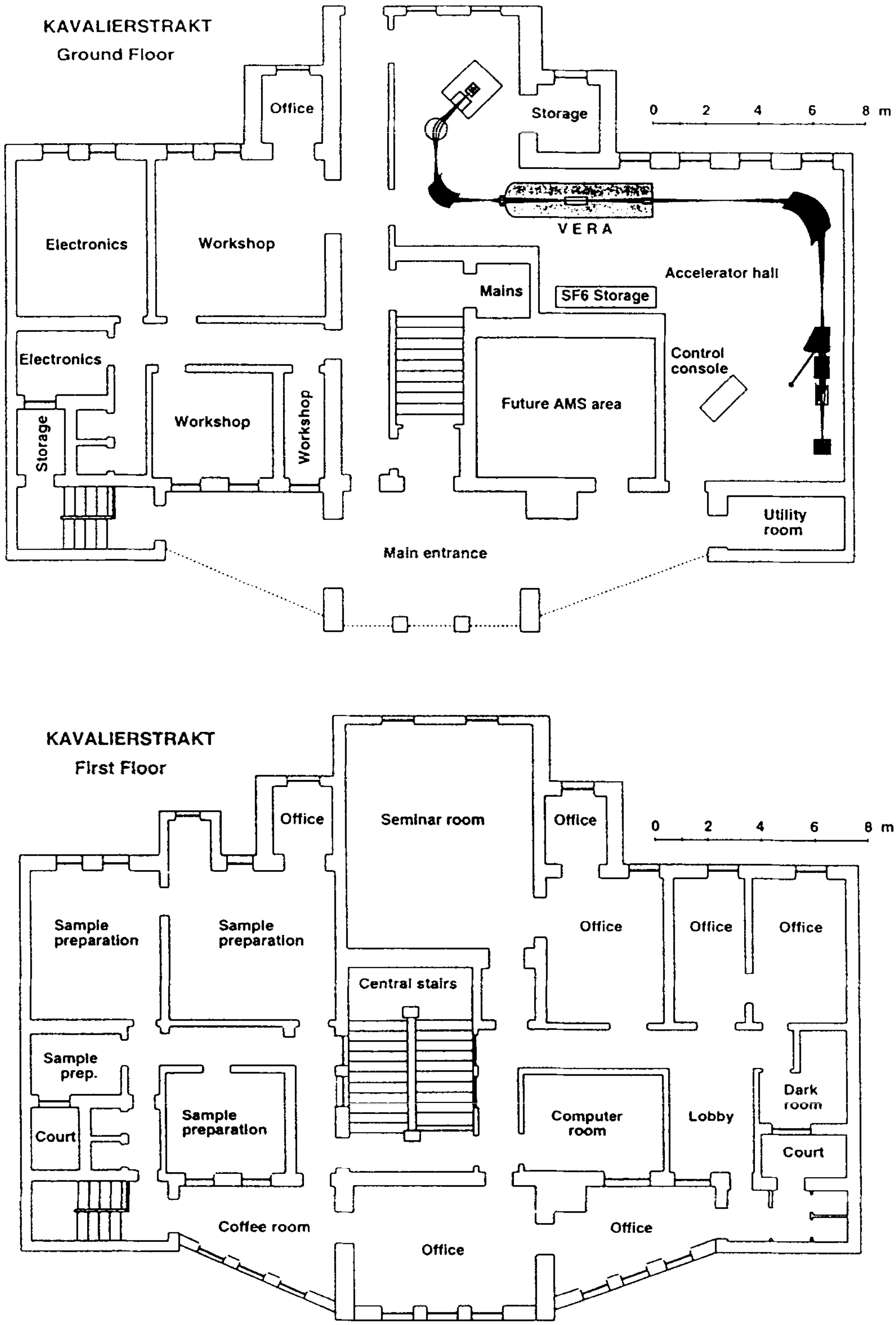

Fig. 1. Floorplan of the VERA laboratory located in a reconfigured small palace at the University of Vienna, called "Kavalierstrakt' Details of the AMS system are shown in Fig. 2.

point near the low energy entrance, and pulling the entire accelerator structure out of the tank. For SF_6 transfer from the tank, a liquid SF_6 storage system (DILO, Germany) was chosen in order to avoid gas storage outside the building, and to save floor space. The room labeled "Future AMS area" is currently used for the central heating system, but will become available when remote heating is being implemented. A maximum electric power of 100 kW is available for the operation of VERA. The water and air cooling system for the accelerator room is designed to provide a maximum cooling power of 70 kW.

3. The VERA AMS system

Fig. 2 shows a schematic lay-out of the VERA AMS system, with the essential components labeled by their respective properties. The maximum mass-energy product of the magnets was chosen to be able to analyze at the low-energy side negative $^{244}PuO_x$ ions between 50 and 60 keV injection energy, and to select at the high-energy side $^{244}Pu^{5+}$ ions at a terminal voltage of 3.0 MV. The choice of a universal AMS system rather than a specialized one for ^{14}C necessarily introduces some compromises (e.g. on the width of the magnet pole gaps). In order to achieve both AMS-type high-precision ^{14}C measurements ($\Delta(^{14}C/^{12}C) \sim 0.5\%$) and the capability for extension to all radionuclides independent of their mass, more stringent requirements on beam emittance and beam optics exist. To set up the beam optics in the proper way, diagnostic elements at all critical locations are required. One such place is the entrance of the tandem accelerator. It would be desireable to have a beam profile monitor at this location, which in our case could not be installed due to space constraints in the building. Nevertheless, the results of the first performance tests of VERA for ^{14}C measurements showed [2] that it should be possible to reach the precision for $^{14}C/^{12}C$ ratios mentioned above. So far, no AMS measurements were performed for heavy radionuclides. However, the beam intensity and transmission observed in the acceptance tests for 18 MeV $^{197}Au^{5+}$ ions [2], where well within expectation.

VERA is fully computer-controlled and integrated into internet, thus providing the possibility to interact remotely with it from essentially any place on earth.

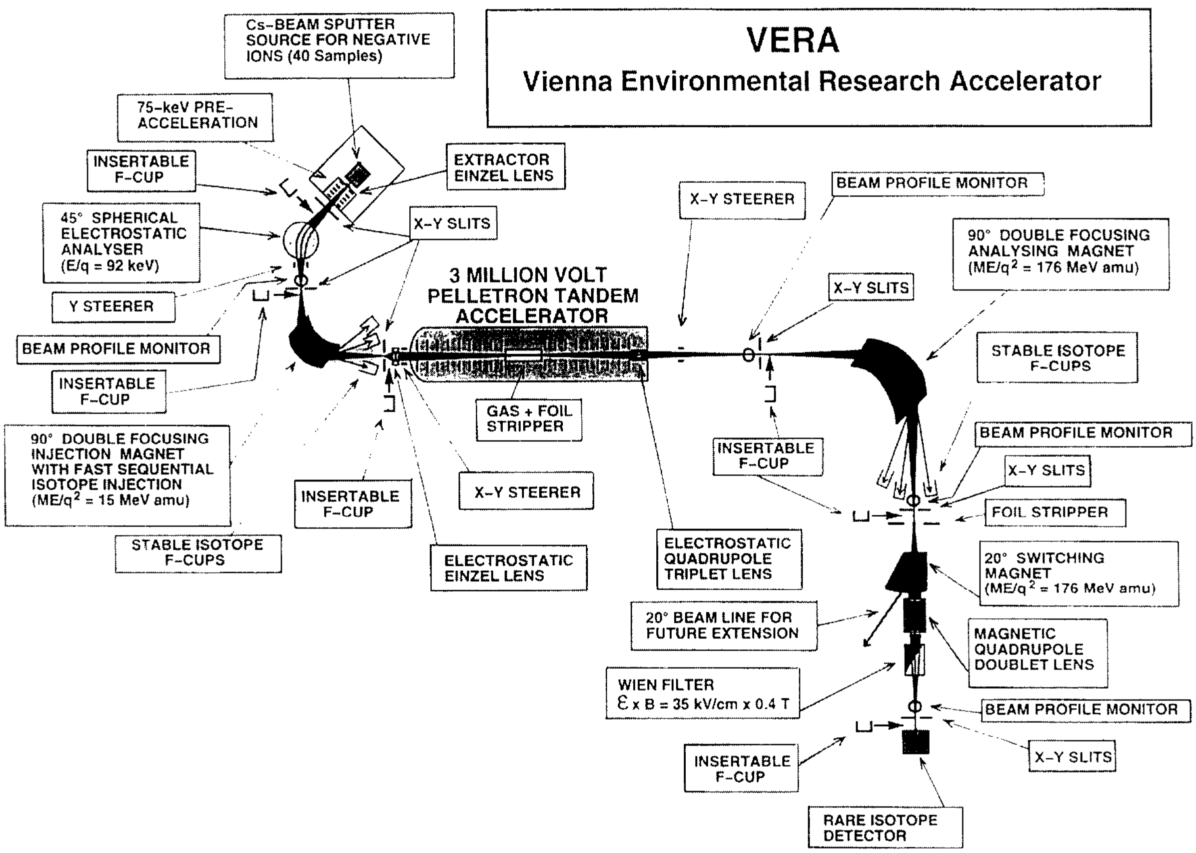

Fig. 2. Schematic layout of the AMS system showing the essential features of VERA. Electric and magnetic rigidities of the beam-analyzing components are given in the respective labels.

4. Scientific goals

VERA is a dedicated AMS facility at the largest University in Austria, and should serve the dual purpose of a typical University laboratory, that is research and education. It is operated by the Institut für Radiumforschung und Kernphysik of the University of Vienna, but it is intended to become both a research facility for AMS-related work and a learning ground for students who are interested in interdisciplinary research. With this in mind, it is hoped that VERA develops into a truly multi-disciplinary center where both students and "seasoned" researchers from various fields work together to solve problems in their respective fields. This will also include technical developments of the AMS method, such as the proposed new detector systems discussed in Ref. [3]. Whether this multidisciplinary scheme will work in the envisioned way, can only be found out in the future.

Current research projects at VERA slowly being implemented include nuclear physics (the measurement of the $^{27}Al(n, 2n)^{26}Al$ reaction cross section via $^{26}Al/^{27}Al$ ratios after bombardment of aluminum with 14-MeV neutrons), archaeology (absolute chronologies for early civilizations in Austria and Central Europe using ^{14}C dating), atmospheric science (^{14}CO concentrations in the atmosphere as a means to study the global OH radical distribution), and paleoclimatology (^{10}Be measurements in loess). The ^{14}CO work will be performed in collaboration with the Max-Planck-Institut for Chemistry in Mainz [4,5], and the AMS labs at the University of Groningen and the University of Uppsala.

5. Conclusions

VERA is a dedicated AMS facility with a great potential for future AMS work. The performance – although far from perfect – encourages us to believe that VERA will become an interdisciplinary research center with wide applications. According to its mission, emphasis will be put on environmental research at large.

Acknowledgements

It is a pleasure to acknowledge the very fruitful collaboration with personel from NEC during all phases of the VERA project, including in particular Max Cichon, Robert Daniel, Dick Kitchen, George Klody. and Jim Schroeder.

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